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THE REDISCOVERY OF *ANOPLODUSA* *ARIZONENSIS* (ORTHOPTERA)

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One of the rarest insects of North America is the beautiful spotted-winged, shield-back katydid known to science as *Anoplodusa arizonensis* (Rehn), described in 1904 from a single male collected near Florence, Arizona. Despite the search of well-known orthopterists since that time, no other specimens, until recently, have been taken in Arizona. In 1909 Rehn and Hebard of the Academy of Natural Sciences of Philadelphia reported the discovery of the first female, on August 11 of that year, in southern Nevada. This female was taken on volcanic flats at the foot of the Bird Spring Mountains of the McCulloch Range on the Nevada side of the California boundary. They wrote, "It flew up in a way reminding one of the swift flight of a *Schistocerca* and did not alight for at least two hundred yards when it perched on the top of another grease-wood bush" (probably referring to *Larrea divaricata*).

During the summers of 1930 and 1931 the writer was employed by Mr. Hebard to search for rare and new species of decticids or shield-back katydids. But despite constant search, and night after night spent on the deserts of the Southwest hunting these elusive insects, *Anoplodusa* might just as well have been a name in orthopterological mythology. It is true that a broken specimen was found among some pinned insects collected by Guy Beevor at the Yermo Inspection Station, but this was not to be compared with the discovery of the living creature in its native habitat.

In 1932 M. J. Oosthuizen of South Africa, then a graduate student of entomology at the University of Minnesota, collected a male *Anoplodusa* on the Mojave Desert near Mojave, California, on June 28. This specimen was attracted to car lights at night, and was later presented to the University of Minnesota. Up to 1941 these four specimens, one of which was much broken, represented the sum total of forty years' collecting.

On July 6, 1941, Mrs. Tinkham and I visited Dr. and Mrs. H. K. Gloyd of the Chicago Academy of Sciences at the Boyce Thompson Southwestern Arboretum near Superior, Arizona, where they were engaged in field work. Mrs. Gloyd mentioned some recently-collected orthoptera, including five specimens of a "green katydid" which had been collected on the highway in the course of searching for nocturnal reptiles and were drying in the refrigerator to preserve their delicate colors. I naturally thought of *Neoconocephalus triops* or *Microcentrum rhombifolium* but to my great surprise, on taking a specimen out of its wrapper, I found in my hands for the first time a splendid male *Anoplodusa arizonensis*. The whole course of the day's events changed suddenly; there was nothing to do but wait until nightfall and begin a search for more.

Accordingly, when it was dark about 9:00 P. M., we set out in two cars, driving west to Florence Junction and south toward Florence, watching for nocturnal snakes on the highway and listening for the song of *Anoplodusa*. Since one of the specimens collected by Mrs. Gloyd had sung while held in the hand, she thought she would recognize the notes if heard again. Several stops were made but each song followed to its owner led, disappointingly, to a *Capnobotes fuliginosus* (Thomas), a large, handsome, black-winged species belonging to the only other fully winged genus of Nearctic decticids. After an hour or two of this we stopped about two miles north of Florence where I took a jaunt out into the creosote-covered plain west of the highway. Within a few minutes the light fell upon a pair of *Anoplodusa* in a creosote bush. After a decade of hunting I had found this rare prize at last. Subsequent search until past midnight revealed no more.

On the following night (July 7) the Gloyds made a special effort to identify the song and locate more specimens of *Anoplodusa*. The singing of these insects was heard in two areas of creosote bush desert about four miles west of Florence, and twelve males and one female were captured. Mrs. Gloyd describes the song as having the same rhythm as that of *Capnobotes fuliginosus* but softer and of a higher pitch, its lower tone approximating the higher tone of the *Capnobotes*.

Two weeks later I made another trip to Florence and after several hours of diligent collecting, which commenced at sunset, located a small colony and obtained thirteen specimens, nine males and four females. Most of these were kept alive and later photographed.

In 1942 additional specimens were collected by the writer in Maricopa County. These are thought to be the first taken in Arizona outside the area of the type locality. Those taken on May 22 were adult, not freshly teneral, indicating that *Anoplodusa* probably matures by the middle of May.

The material collected by the Gloyds was turned over to me for study with the request that an account of this interesting species be prepared for publication by the Chicago Academy of Sciences.

Anoplodusa arizonensis (Rehn)

Fig. 1, 2

1904. *Drymadusa arizonensis* REHN, Proc. Acad. Nat. Sci. Philadelphia, vol. 56, p. 573 (Type male, collected by C. R. Biedermann at Florence, Pinal County, Arizona; in collection of Academy of Natural Sciences, Philadelphia).—KIRBY, Syn. Orth., vol. 2, 1906, p. 180.
1907. *Anoplodusa arizonensis* CAUDELL, Proc. U. S. Nat. Mus., vol. 32, p. 319, fig. 25 (description).—REHN AND HEBARD, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, 1909, p. 479 (Type female, collected by James A. G. Rehn and Morgan Hebard in Bird Spring Mts., Nevada; in collection of Academy of Natural Sciences, Philadelphia).—HEBARD, Trans. Amer. Ent. Soc., vol. 51, 1935, p. 310 (listed).—TINKHAM, Journ. N. Y. Ent. Soc., vol. 46, 1938, p. 349 (recorded at light).

Material Examined.—Pinal County, Arizona: 2.3-4.5 miles W. of Florence, June 12, 1♂, June 13, 1♂ 1♀, June 15, 1♂, July 3, 1941, 1♂, on highway at night; 3.5-4.5 miles W. of Florence, July 7-8, 1941, 12♂ 1♀, on creosote bushes near highway, between 11.00 P. M., and 1:30 A. M., H. K. and L. K. Gloyd; 1.6 miles N. of Florence, July 6, 1941, 1♂ 1♀ (mating pair), in creosote bush at night; a few miles W. of Florence, July 20, 1941, 9♂ 4♀, also in creosote bushes at night, E. R. Tinkham.

Maricopa County, Arizona: 3-3.5 miles S. of south end of Sierra Estrella, May 22, 1942, 3♂ 2♀; Vekol Wash, May 29, 1942, 1♂; 1 mile E. of Vekol Wash, May 29, 1942, 1♂, E. R. Tinkham.

These specimens are deposited in the museum of the Chicago Academy of Sciences, the Museum of Zoology, University of Michigan, and the Tinkham Collection.

Measurements (in mm.).—The range in size of the male topotypes is as follows: body length 25.0-29.0, total length to tip of tegmina 47.0-53.5, pronotum 6.5-7.4 in length x 4.5-5.0 in breadth, tegmina 40.0 x 6.5-46.0 x 7.4, caudal tibiae 27.0-31.0, caudal femora 25.0-28.5, antennae 48.0-52.0; of topotypic females: body length 25.0-29.0, total length to tip of tegmina 55.0-58.5, length to tip of ovipositor 51.5-58.0, pronotum 7.0 x 5.0-7.8 x 5.0, tegmina 48.0 x 7.0-51.5 x 7.0, caudal tibiae 30.0-31.0, caudal femora 28.5-30.0, ovipositor 25.4-30.0.

Coloration.—The sexes are nearly identical in coloration. It is almost impossible to preserve the beautiful delicate green of the living creature without some slight discoloration. The colors in life are as follows. Antennae pale reddish brown, antennal scrobes deep foliage green. Eyes chestnut, margined especially posteriorly with a narrow ring of brownish black. Face and genae and mandible bases very pale greenish white with a tinge of reddish brown posteriorly on the occiput. Clypeus pale greenish and labrum ivory in color. Pronotum dorsally with an arc of Chinese white on the fore part of the prozona, two small spots of white almost central on the pronotum, and the posterior half of the metazona Chinese white. Remainder of the dorsum of the pronotum with pale brown caudad of the arc on the prozona, and a central patch of green on the metazona outwardly margined with dark reddish brown, especially at the humeral angles where a spur or streak runs down to the center of the lateral lobes of the metazona. Remainder of the lateral lobes of the pronotum deep viridian with lower and posterior margins broadly bordered with nacreous. Mesothorax with the epimeron viridian and the sternum white. Metathorax with epimeron nacreous, posteriorly margined with dark reddish brown and pale chestnut above with the sternum dull white. Abdomen nacreous on the sides with deep viridian on the fleshy lateroventral portions; sternites cream. Bases of legs deep viridian with the fore and middle femora whitish tinged with pale viridian. Caudal femora whitish flecked with pale viridian and with a nacreous area on the dorsal basal third with the dorsal margin of the internal pagina in the basal third flecked with brown. All tibiae pale greenish white with the small tibial spines reddish brown. Ovipositor pale leather brown. Tegmina of both sexes deep viridian along the longitudinal veins and with three rows of large circular nacreous spots. The stridulation field of the male tegmen is reddish brown with only traces of brown on the green corresponding area of the female. The wings are transparent.

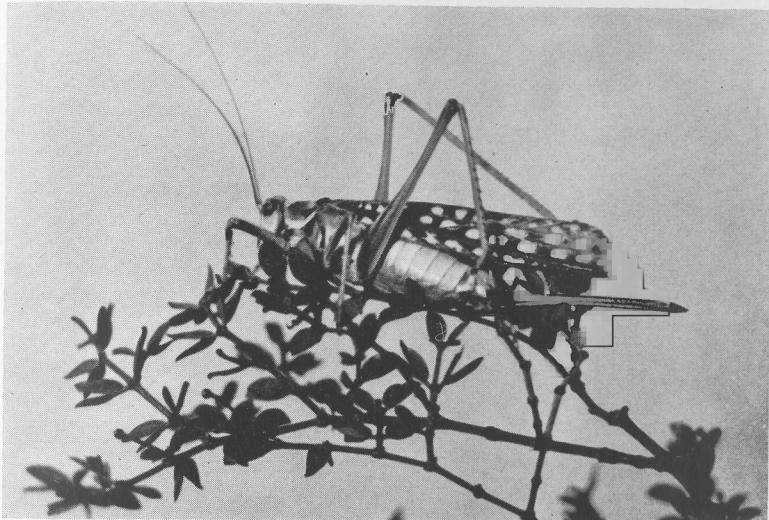


Fig. 1. *Anoplodusa arizonensis*, female, in creosote bush.
Flashlight photograph by E. R. Tinkham.



Fig. 2. *Anoplodusa arizonensis*, male, in creosote bush.
Photo by H. K. Gloyd.

Adaptive Coloration.—It is not surprising that the commonest plant of the desert, the creosote bush, *Larrea divaricata*, whose distribution closely delineates the distribution of the various deserts of North America, should support an interesting orthopteran fauna despite its decidedly unpalpable qualities. The leaves are very sticky and strongly pungent. Among insects living in the greenery of creosote foliage, there has been evolved a remarkable series of convergent adaptations toward concealing coloration in three subfamilies of two distinct families. In *Anoplodus* the nacreous spots on the deep viridian tegmina might simulate the light and shadow of the creosote leaves: the green the leaves and the white spots the sunlight filtering past the leaves. Or perhaps it is the reverse: the green representing the shadows under the leaves and the nacreous spots the sun glistening and reflecting off of the surface of the leaves. Whatever the correct answer the response has been the same. The much smaller katydid, *Insara covilleae* Rehn and Hebard, in the subfamily Phaneropterinae is creosote green with similar white spots on its tegmina. The creosote grasshoppers, *Boettix argentatus* and *B. punctatus* Scudder, are creosote green with nacreous trimmings on various portions of their bodies. The very rare meloid beetle, *Eupompha fissiceps* LeConte, which feeds on the seeds and flowers of the creosote bush, is rendered inconspicuous among the leaves by its shining rough metallic green body. However, grasshoppers such as *Clematodes larreae* Scudder and *Ligurotettix coquillettei* McNeill which dwell on the dark greyish stems of the creosote bush mimic the stems and not the leaves. This adaptive coloration may indicate that these orthopterans have been associated with the creosote bush for an inestimable period of geological time.

Biology.—As specimens have been taken from April through June and July to early August it would appear that the species becomes adult in the early spring and persists until late in the summer. Some captured in mid-July had the tegminal apices somewhat frayed, indicating nearness to the close of their season. Furthermore, females possessing mature eggs in mid-July and later suggests the same conclusion.

Since the eggs are laid in late July or early August at about the time the desert rains commence, it appears highly probable that the ova hatch in the fall and the nymphs develop during the fall and late winter to mature in the early spring. This assumption is based on knowledge of other orthoptera in the region.

The six females captured by the writer in 1941 were kept and fed until they died a natural death in late July and early August when their eggs were dissected out of their bodies. In two the ovaries were

immature, one had only three eggs, two others contained 22 and 28 ova respectively and a few small, yellowish, immature ova which were not counted. The sixth had a complement of 42 eggs all of which were mature and pearly gray in color. This indicates that each ovary produces about 21 to 22 ova in optimum fecundity.

Ova.—The eggs measure 5.5-5.6 x 1.6-1.7 mm. The color is a lustrous pale violet-gray, typical of any decticid egg. The form is oval-elliptical with evenly rounded ends which appear closely similar. To the unaided eye the surface appears smooth and shining. Under magnification of 10.5 power the surface of the chorion or shell is covered with minute shallow pits which at 19 power have a slight suggestion of hexagonal outline. At 30 power the cells are observed to be quite closely crowded, not following any definite pattern of rows but appearing to be arranged somewhat in groups or rosettes. On the outer edge, or the more convex side just below one end, about eight small sunken areas are found in a more or less transverse groove. These are the micropylar areas and indicate the anterior pole of the egg. They are slightly discolored and stand out against the smooth shining surface of the chorion. The center of each area appears to have a minute fluff or excrescence which is indistinct at this power. Under 160 power of the microscope the body cells appear shallow with thick smooth rounded cell walls. The floor of each cell appears slightly granular with a large central pore or pit. The cell walls are hexagonal in outline but due to the thick walls most of the cells appear to be square or diamond shaped. The cells do not run in rows but appear to be grouped in small patches. The tuft-like objects seen in the center of the micropylar areas at lower power are in reality a small papule area formed by a number of raised cells. These cells are very deep with thin walls and consequently these and the shallower thinner-walled cells of the surrounding micropylar area appear larger than the very shallow thick-walled cells covering the remainder of the egg chorion.

Nymphs.—The nymphs of *Anoplodus* still await discovery.

Food.—*Anoplodus* appears to be a delicate eater, partaking of only small amounts of creosote bush, *Larrea divaricata*, which appears to be its only food plant. In captivity it may easily starve to death if fed creosote leaves alone, probably due to its confinement. The writer kept his specimens alive by feeding them freshly killed grasshoppers. In this regard it appears that *Anoplodus* is only mildly carnivorous in captivity, quite unlike its huge relative, *Capnobotes fuliginosus*, which is decidedly a ravenous carnivore. An examination of the spination of the fore and middle legs of these two genera will bear out this observation. In *Anoplodus*

the fore and middle tibial spines are very minute, indicating lack of use in grasping prey, whereas in *Capnobotes* these spines are large and well developed and are used in capturing prey. The delicate green body colors of *Anoplodusa* further suggest a green herbivorous diet.

Song.—The song of *Anoplodusa arizonensis* is closely similar to that of *Capnobotes fuliginosus* but weaker and less audible in character. On the night of July 20, 1941, which was quite sultry with heavy black storm clouds on the southern horizon, the song was first heard at 10:20 P. M. Later, two males of *Capnobotes* which were singing in the immediate vicinity had to be silenced so that the several males of *Anoplodusa* could be heard. The singing males were not difficult to capture. Like that of *Capnobotes fuliginosus*, their song is difficult to describe. It is a sort of quavering "tsz-e-e-ek-----tsz-e-e-e-ek-----tsz-e-e-e-ek-----" continued indefinitely. Each "tsz-e-e-ek" was one second in duration punctuated by a very brief pause of about one-half a second in length. The males were singing at their best about midnight. Males captured May 22, 1942, were singing shortly after sundown.

Habitat.—*Anoplodusa* has been found only on the creosote covered areas of the desert. Its wide but highly discontinuous distribution may indicate that it is sensitively and perhaps precariously adjusted to its environment. Climate, as with most insects, is probably a factor controlling its abundance. The winter of 1940-41 broke all records since the first decade of the present century in abundance of rainfall and in April and May, 1941, the usually barren desert pavement was a carpet of many flowers. Such a season of growth may have reduced the mortality in *Anoplodusa* and made its rediscovery possible.

Distribution and Faunal Designation.—*Anoplodusa arizonensis* is a member of the Lower Sonoran Faunal Region and is restricted to the Sonoran Desert. Its range runs in a long narrow strip from Florence, Arizona, to the creosote areas of the Mohave Desert in California. It is known at present only from the specimens mentioned in this paper.